X-card Installation Manual (X641, X661, X662)

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1 Disclaimer of liability and limitation of warranty

Where the X-card is supplied as a component and not as part of a complete control system it is assumed that the purchaser has sufficient electrical and electronic knowledge to handle the component competently.

It is further assumed that the purchaser has sufficient knowledge of safe working practices and the relevant Health & Safety regulations which apply to working with electrical and electronic systems to work safely with the component.

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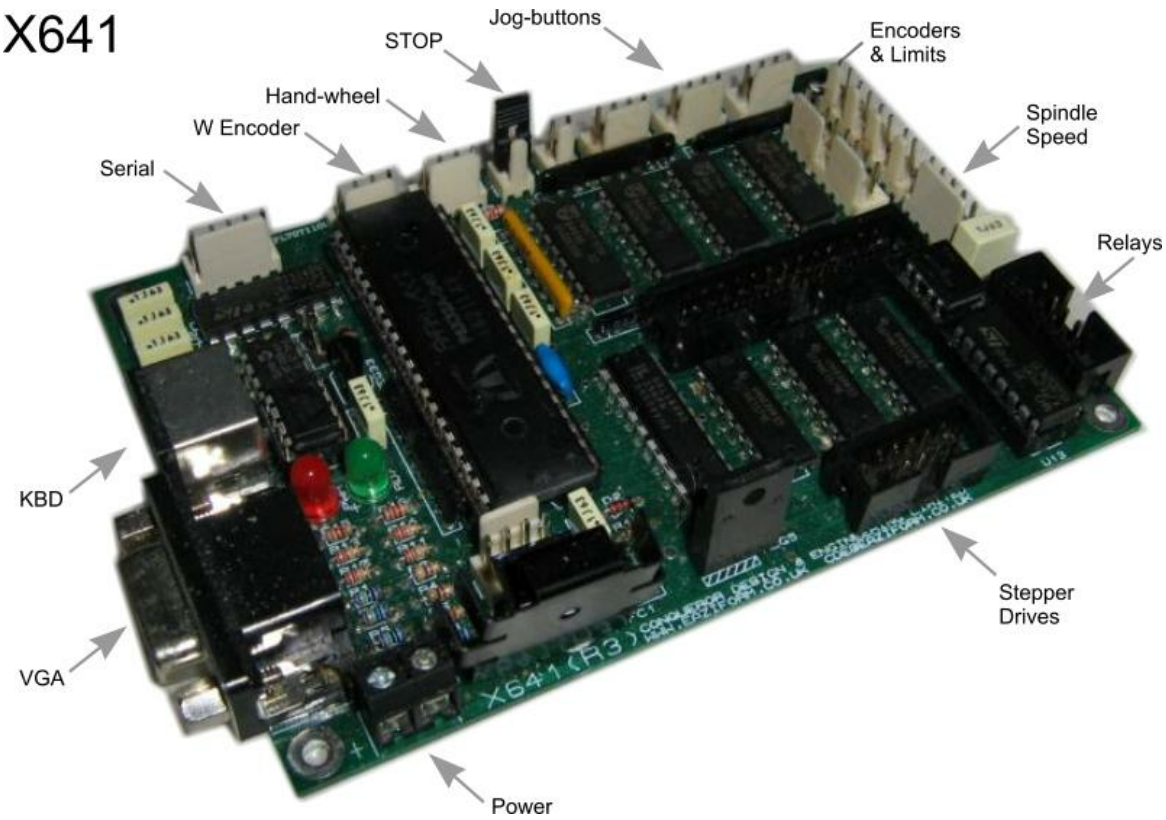
2 Introduction to the X-cards



The X-cards have been designed to control CNC lathes, milling machines, PCB drills, routers, etc. In fact any machine which has 1, 2, 3, 4, 5 or even 6 stepper motor driven axes (or servo driven if pseudo-stepper cards are used). The stepper motors can also, optionally, be controlled in a closed-loop mode with the addition of standard quadrature-encoders in either strip or rotary form.

The card also provides for on/off and speed control of an AC or DC spindle motor and common auxiliary equipment such as coolant pumps.

A machine fitted with an X-card can be operated in full stand-alone mode without requiring a host computer. A standard VGA monitor is used as a display and a PC PS2 keyboard can be used for input and programming.

A low-cost 2-channel encoder can be connected to the quadrature-encoder connector QH to provide a hand-wheel for positioning the axes. The manual/stand-alone mode of the card is 'hand-wheel' ready.

The card is supplied with EaziCNC editing and programming software for Microsoft Windows. Please refer to the separate EaziCNC manual for details on operating the EaziCNC software.

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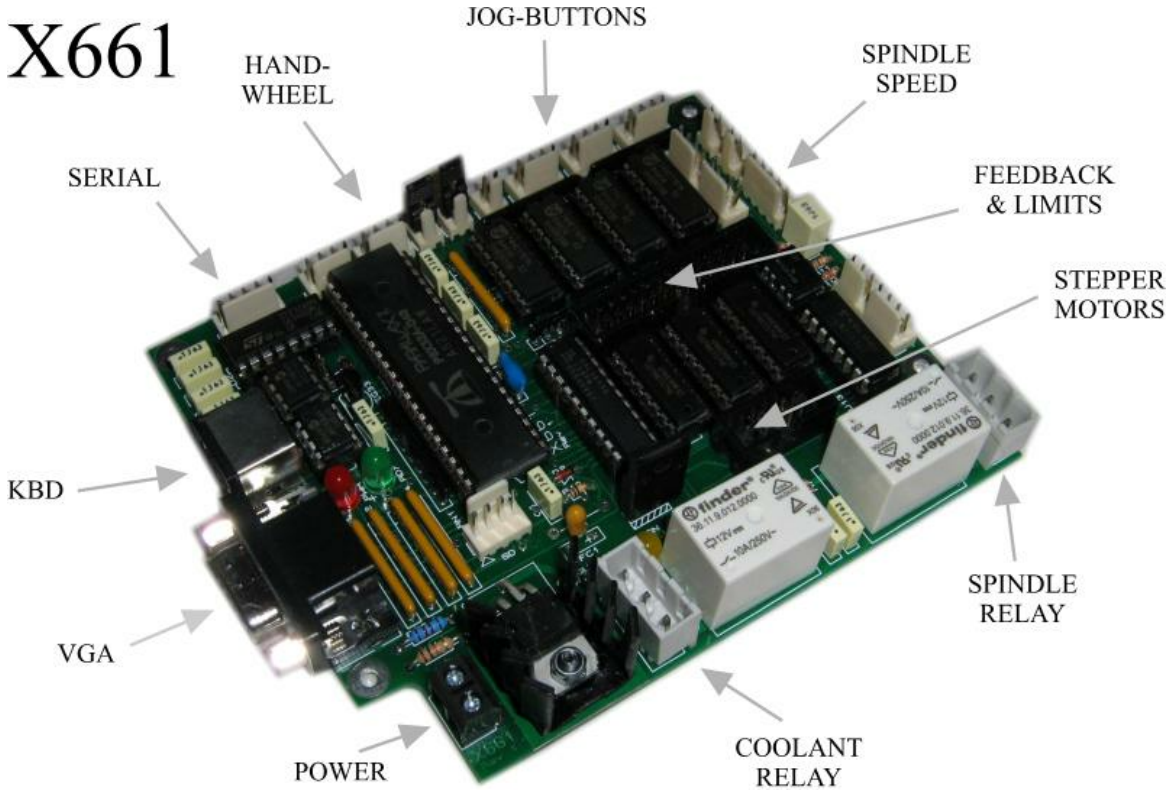

X661 card (2 power relays fitted)

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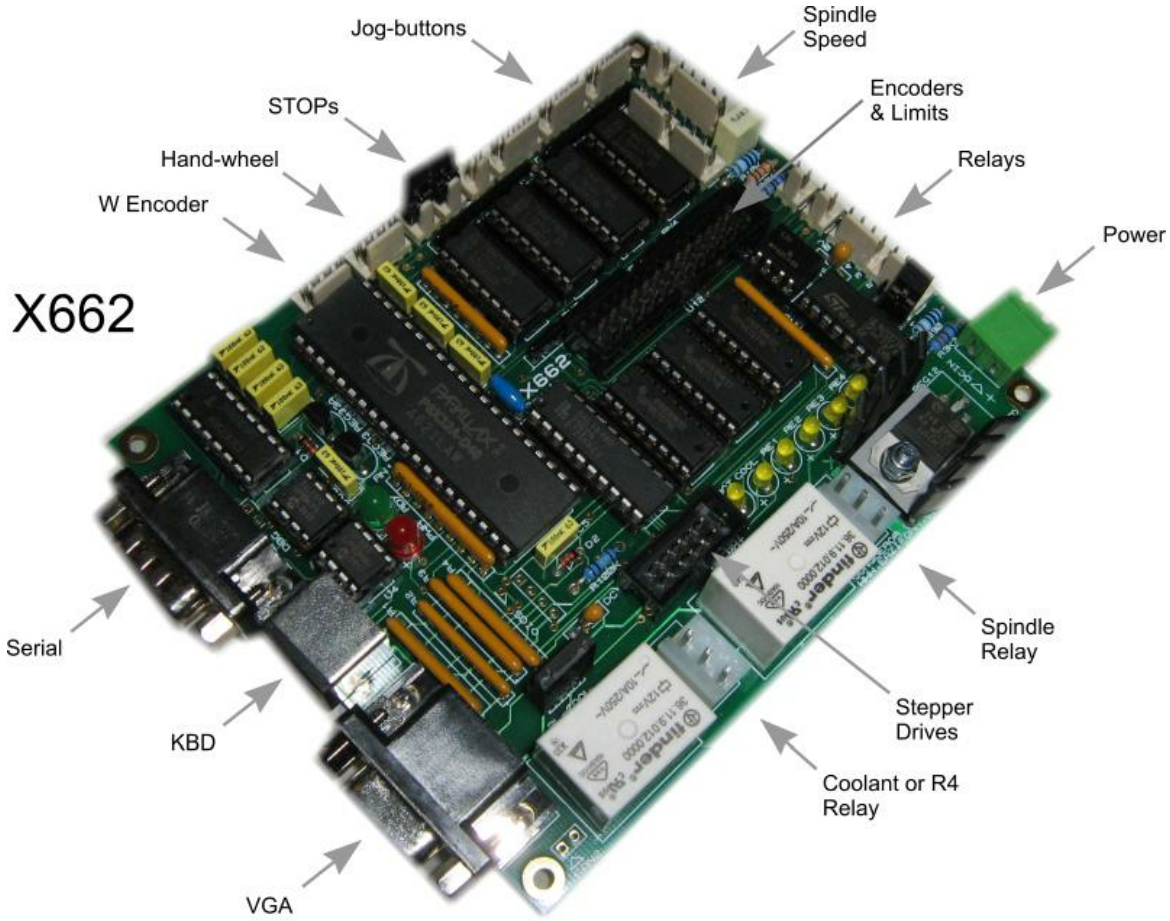

X662 card (2 power relays fitted)

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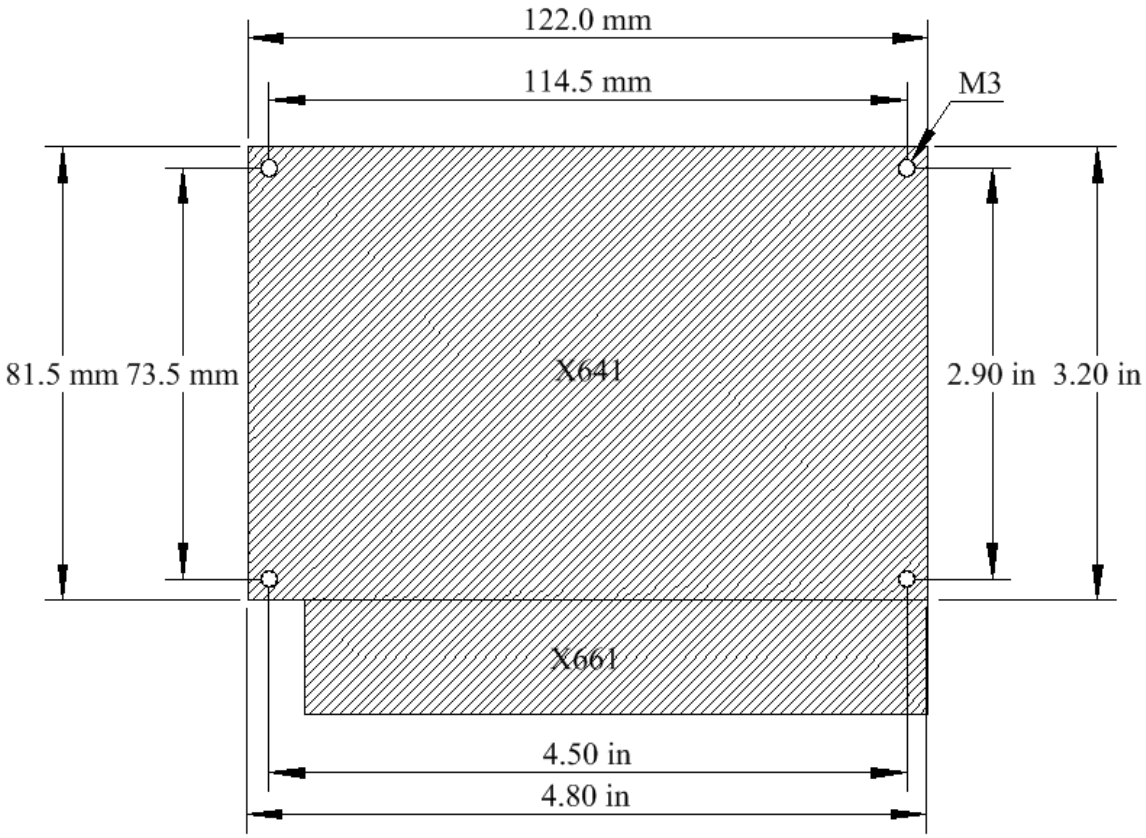
2.1 Mounting details



Leave 1"/25mm of space around the board to allow for connections and cooling.

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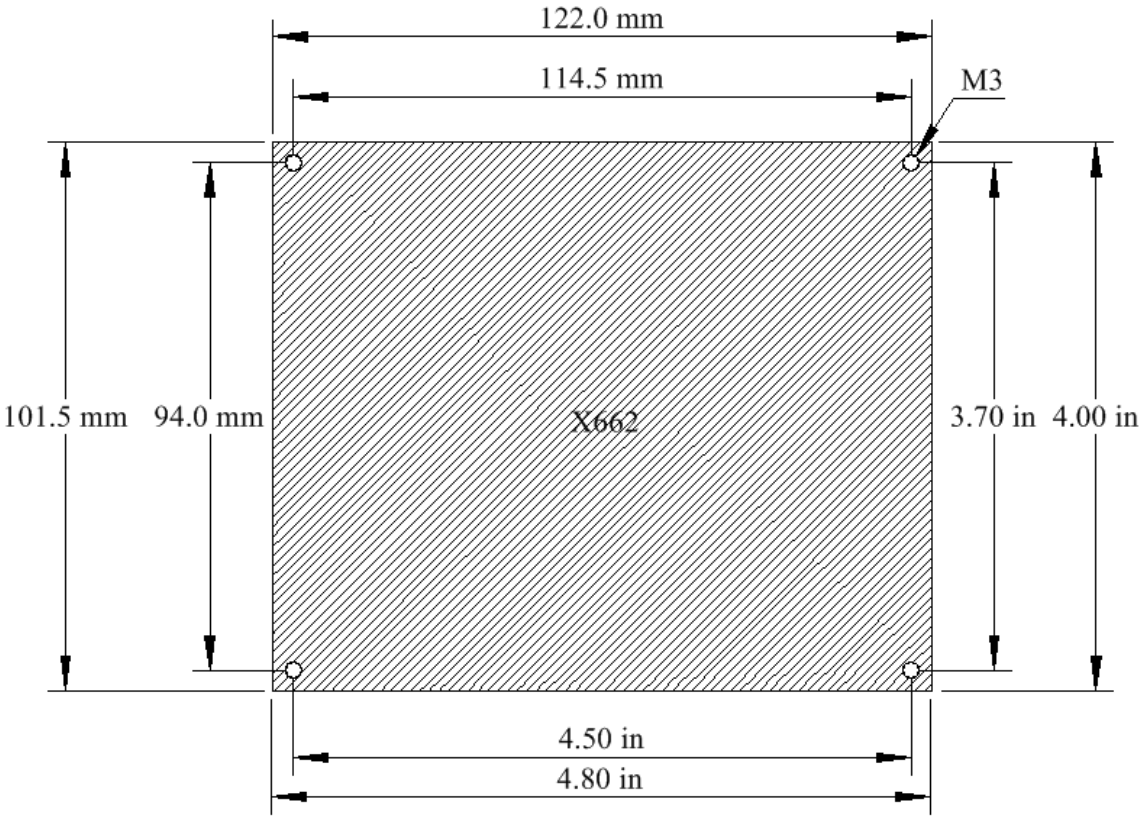

Leave 1"/25mm of space around the board to allow for connections and cooling.

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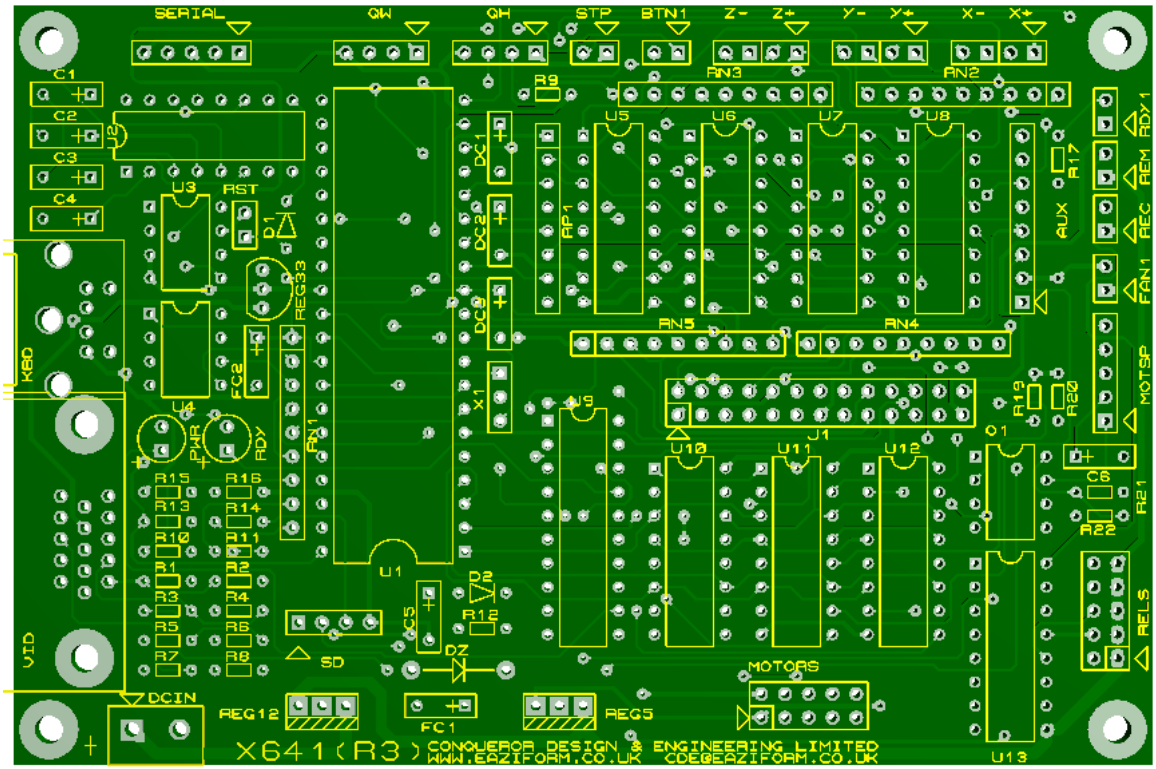
2.2 Components of the card - X641



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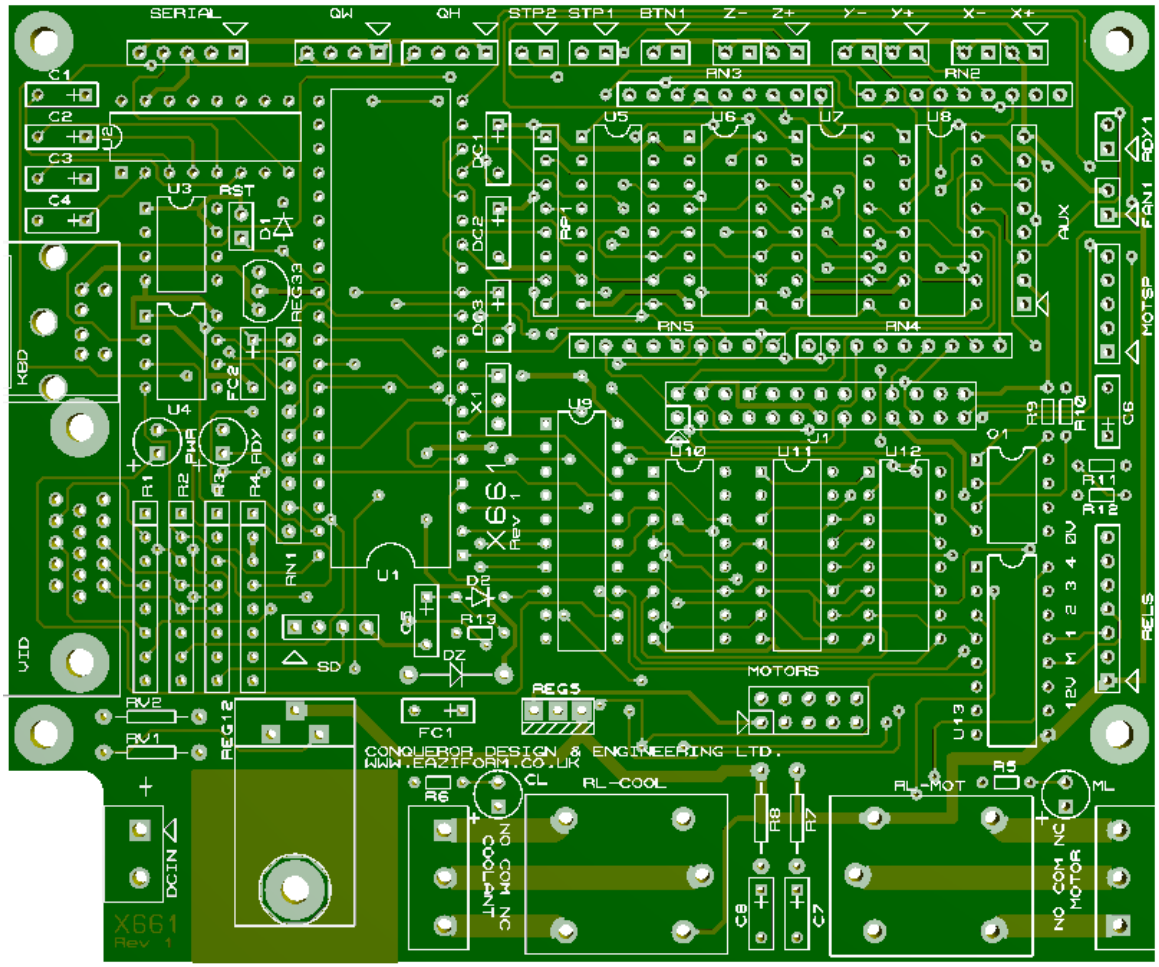
2.3 Components of the card - X661



The X661 is similar in layout to the X641. The differences are...

- There are 2 power relays
- The relay plug has been changed to a 7-pin inline connector so that it cannot be confused with the 10-way connector for the stepper motor drives
- The motor speed (MOTSP) and fan connectors (FAN1) have been moved
- There is no separate plug for the coolant relay driver and the extra/auxiliary motor relay driver is on the relay plug
- There are 2 stop connectors (STP1 & STP2) - both need to be closed/shorted for the spindle and coolant relays to be enabled
- The voltage regulator layout is different

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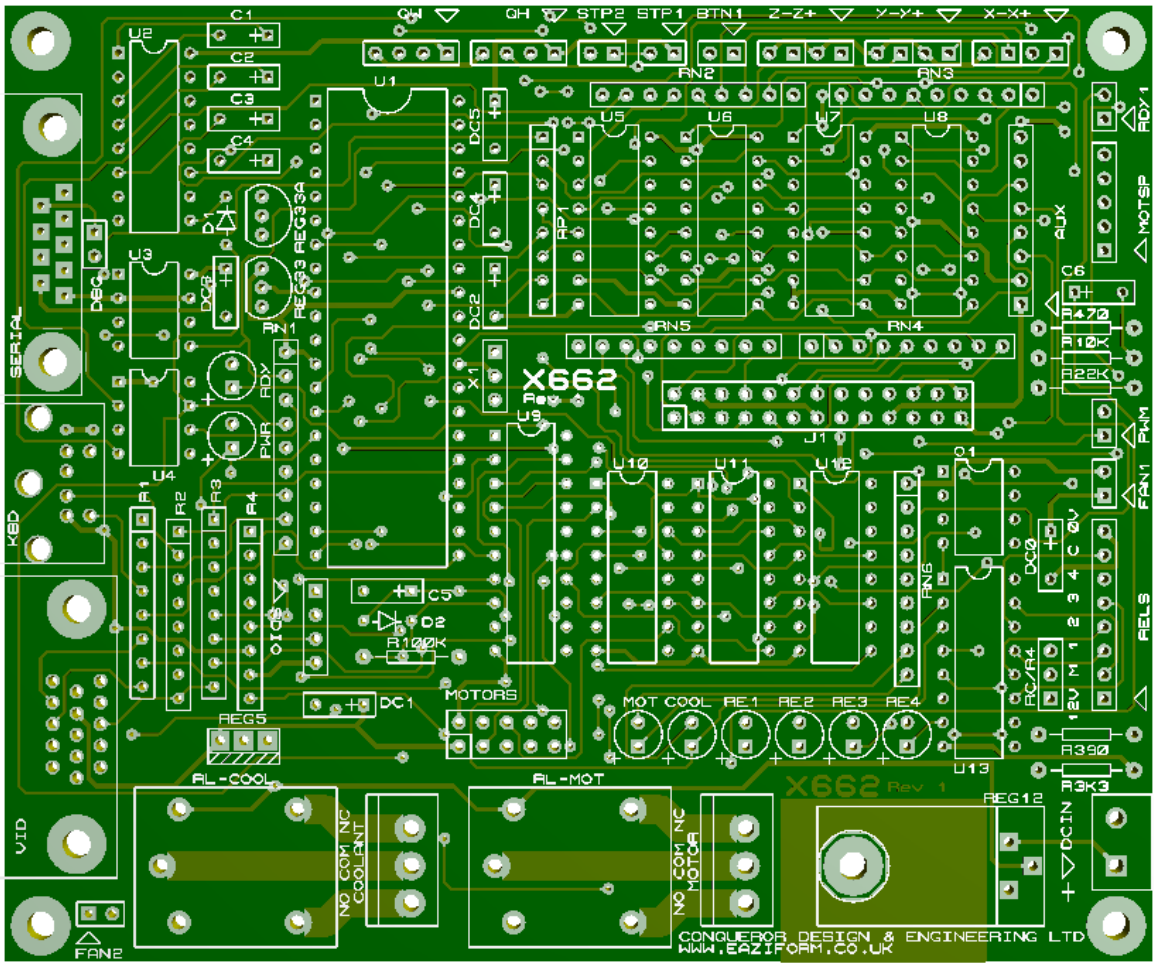
2.4 Components of the card - X662



The X662 has similar functionality to the X641 and X661. The differences are...

- There are 2 power relays
- The relay plug has been changed to a 8-pin inline connector so that it cannot be confused with the 10-way connector for the stepper motor drives
- There are LED indicators (optional) for the MOTOR, COOLANT and auxiliary relays
- The motor speed (MOTSP) and fan connectors (FAN1) have been moved
- There is no separate plug for the coolant relay driver and the extra/auxiliary motor relay driver is on the relay plug
- There are 2 stop connectors (STP1 & STP2) - both need to be closed/shorted for the spindle and coolant relays to be enabled
- The voltage regulator layout is different
- The X662 has different mounting holes than the X641 and X661.
- The X662 does not require a conversion cable for the RS232 - there is a standard 9-pin serial port onboard
- The X662 is designed to be mounted through a panel so the RS232, keyboard and VGA connectors are all at one end of the card

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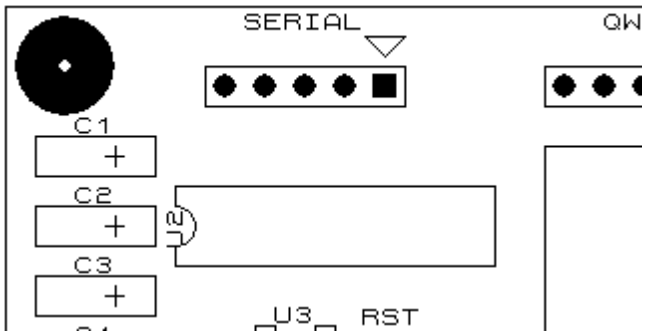
2.5 RS232 serial interface



X641 / X661 Pin	Signal	Pin on a 9-pin D (X662)
1	Receive Data (RCD)	2
2	Transmit Data (TXD)	3
3	Ground	5
4	Factory-test - do not connect	6
5	+5V	9

The X641 and X661 cards are supplied with a serial cable adaptor configured as a standard PC AT 9-pin port. A standard PC-AT to PC-AT serial cable (a cross-over cable) can be used with this adaptor. The X662 has a standard 9-pin D connector.

The default protocols are 115200 baud, 8 data bits, no parity and 1 stop bit (older cards may operate at either 19200 or 38400 baud until the firmware is updated).

The board will use XON/XOFF flow controls by default.

If you are making your own cable you should wire it as follows (if you use shielded cable connect the shield to the plug casing at the PC end only!)...

PC 9-pin DB-F	X641 5-pin plug	X641-serial-cable
2	2	3
3	1	2
5	3	5

A +5V power connection is provided on pin 5 of the serial connector (and on pin 9 of the supplied 5-pin to 9-pin D cable adaptor). This will not interfere with normal operation but can be used to power wireless serial-to-BlueTooth converters such as the Roalan BT/232 (http://www.roalan.co.uk).

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Roalan BT/232 serial-to-BlueTooth converter

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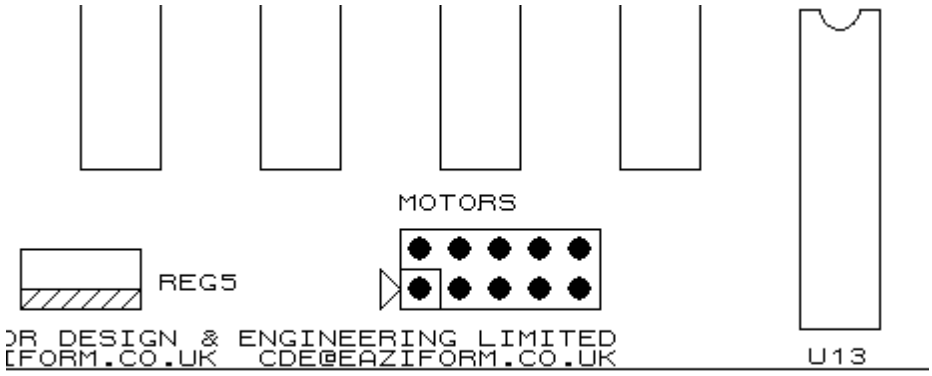
2.6 Connector for stepper motor drives



Pin	Function
1	VCC (+5-volts).
2	Ground (0-volts).
3	STPX. Clock/Step-pulse for X motor.
4	STPY. Clock/Step-pulse for Y motor.
5	STPZ. Clock/Step-pulse for Z motor.
6	STPE. Clock/Step-pulse for E/U motor.
7	DIR. Motor step direction. Shared by all drives.
8	ENABLE. Used to idle the stepper motor drives when not in use.
9	STPV. Clock/Step-pulse for V motor.
10	STPW. Clock/Step-pulse for W motor.

Connector MOTORS on the X-card card is used to attach the separate stepper motor drive cards.

If the stepper motor drive cards STEP1, STEP2, STEPHP1 or SERVO1 are used then the connections to the cards can be made via a straight ribbon cable "bus" and the cards can be configured to identify as X, Y, Z, E/U, V or W. If other drive cards are used then it will probably be necessary to use a terminal block or Y-cables to connect the shared signals to the different cards.

The OPTOCARD and OPTOCARD2 are available for connecting 3rd party stepper motor cards. The X641SC stepper converter card is also available if separate direction signals are required for 3rd party stepper motor cards.

The timing of the motor control signals from the X-card card is...

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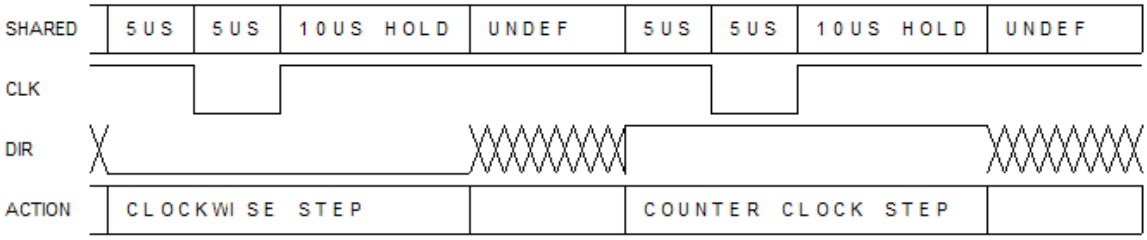
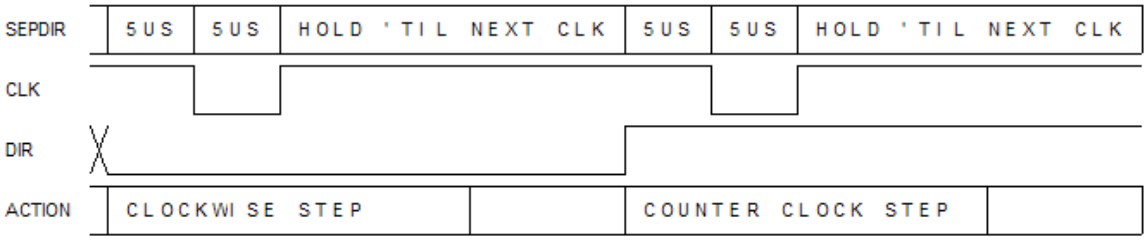
Signal timings for shared direction output



Signal timings for separate direction outputs



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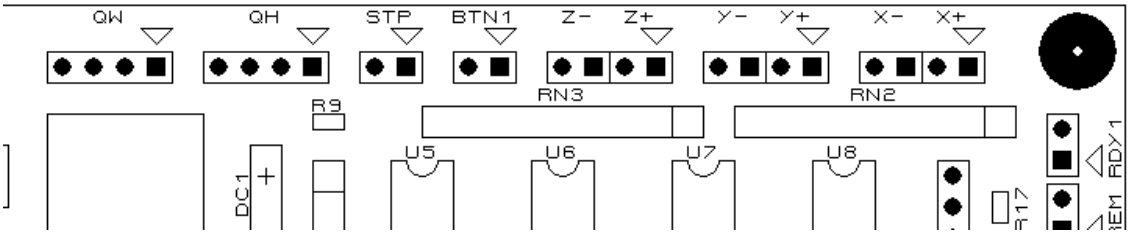
2.7 Connectors for jog-buttons, optical encoders and the safety-circuit

The connectors for the jog-buttons, limit-switches, optical encoders and the safety circuit are located along the top edge of the board...



In each case the square pad located inside each connector indicates pin1 (it is at the right of the connector in each case).

X+, X-, Y+, Y-, Z+ and Z- Axis Jog-button, BTN1 connectors

Pin	Function
1	Button signal. Short to pin 2 to activate button (i.e., connect the switch across the 2 pins)
2	Ground

STP - Safety circuit connector

Pin	Function
1	Safety circuit +.
2	Safety circuit -

QH and QW feedback/encoder connectors

Pin	Function
1	+5V
2	Quadrature A signal
3	Quadrature B signal
4	Ground (0-volts).

If the jog-buttons are to be connected at a distance from the control card or electrical interference is an issue then the OPTOCARD2 can be used.

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2.8 AUX connector

The AUX connector is reserved for future expansion and special functions.

Pin	Function
1	VCC/+5V
2	GND/0V
3	AU3 (auxiliary output)
4	F15 (input)
5	AU4 (auxiliary output)
6	F16 (input)
7	AU5 (auxiliary output)
8	GND/0V

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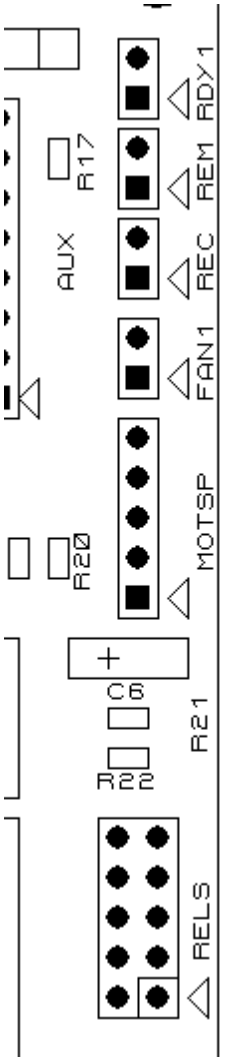
2.9 Relay driver connectors and fan

The relay connectors and spindle motor connector are located along the right edge of the X641.



For REM, REC and FAN1 pin 1 is the square pin in the connector (*In practice the polarity of the connections does not matter unless solid-state relays are used*).

Pin	Function
1	+ relay drive voltage.
2	- relay drive voltage.

The onboard relay drives can drive relays requiring up to 500 mA but the combined current for all relays & fans should not exceed 1,250 mA.

Relay	Function
REM	To control the spindle motor run/stop.

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REC	To control the coolant pump if fitted.
FAN	Always on... can drive cooling fans, work-lights, etc.

Any relays connected to the drivers should be fitted with suitable snubbers to protect the loads that they are driving.

The RELS plug pin-out is...

Pin	Function
1	+12
2	Spindle motor on off relay -
3	+12
4	RE1 -
5	+12
6	RE2 -
7	+12
8	RE3 -
9	+12
10	RE4 -

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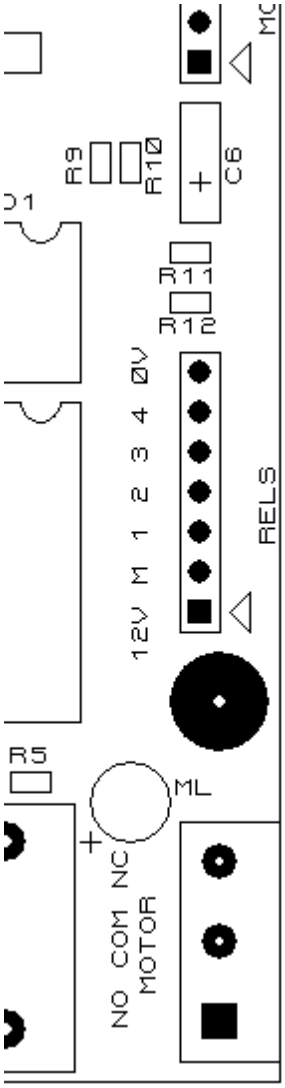
2.9.1 Relay driver connectors - X661



The relay connector on the X661 has been changed to a 7-pin inline connector. The pin-out is...

Pin	Function
1	+12
2	Spindle motor on off relay (M)
3	Relay 1
4	Relay 2
5	Relay 3
6	Relay 4
7	0V/Gnd

The pin-out is also marked on the silk-screen of the board.

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To control a 12-volt relay one side of the coil needs to be connected to the +12 (pin 1) and the other side of the coil to the relevant relay pin - 'M'/pin2 for the spindle motor, '1'/pin3 for auxiliary relay #1 etc. The 0V/GND supply is provided so that additional circuits - such as an electronic interlock for spindle reversing using the motor output and auxiliary relay #4 - can be powered.

The connections for the 10A/250V relays for spindle and coolant control are also marked on the PCB using the standard conventions of...

Pin	Function
1	NO - normally open - connected to common when the relay is off
2	COM - common
3	NC - normally closed - connected to common when the relay is on

If the power relays are not fitted then they can be fitted by the user at a later date - they are Finder series 36.11.9.012.0000

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2.9.2 Relay driver connectors - X662

The relay connector on the X661 has been changed to an 8-pin inline connector. The pin-out is...

Pin	Function
1	+12
2	Spindle motor on off relay (M)
3	Relay 1
4	Relay 2
5	Relay 3
6	Relay 4
7	Coolant relay (C)
8	0V/Gnd

The pin-out is also marked on the silk-screen of the board.

To control a 12-volt relay one side of the coil needs to be connected to the +12 (pin 1) and the other side of the coil to the relevant relay pin - 'M'/pin2 for the spindle motor, '1'/pin3 for auxiliary relay #1 etc. The 0V/GND supply is provided so that additional circuits - such as an electronic interlock for spindle reversing using the motor output and auxiliary relay #4 - can be powered.

There is a jumper (RC/R4) next to the relay connector which allows the 2nd onboard relay to be configured as coolant (C) or auxiliary relay #4. The 1st onboard relay is always dedicated to spindle on/off.

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2.10 Spindle speed control

The spindle speed connector MOTSP pin-out is...

MOTSP connector (pin 1 is the square pin)

Pin	Function
1	Positive supply for analogue output
2	Analogue output
3	Negative supply for analogue output
4	Positive terminal of motor on/off optical switch
5	Negative terminal of motor on/off optical switch

The optical switch can sink 25mA of current - it should not be used to switch higher current loads.

To switch higher current loads use the dedicated relay driver (see Relay driver connectors and fan).

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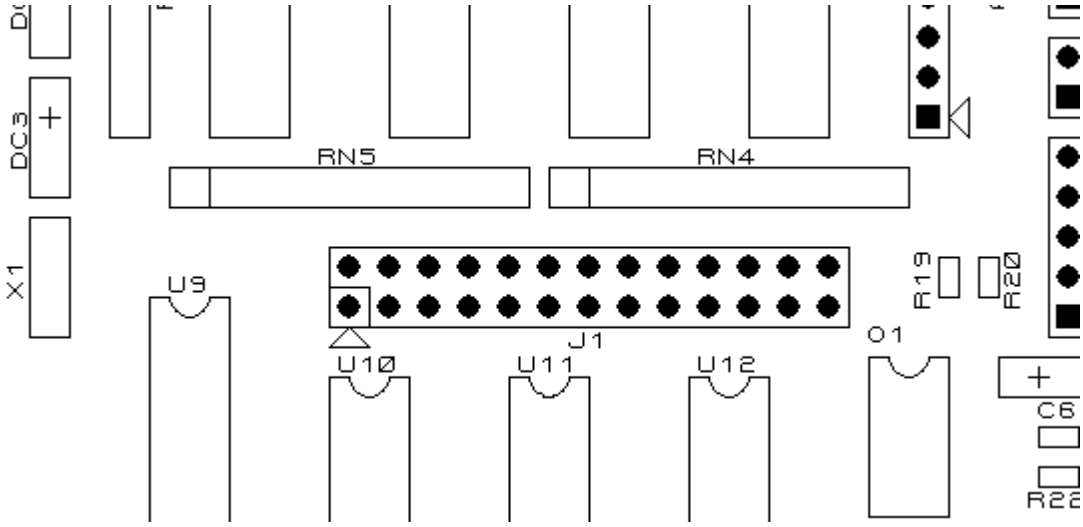
2.11 Encoder and limit-switch connector J1



The card has connectors for 7 quadrature-encoders... for the axes X, Y, Z, E/U, V, W and for the electronic hand-wheel.

The electronic hand-wheel (QH) and W encoder (QW) are discrete 4-pin connectors on the card (see Connectors for Jog-buttons, Optical Encoders and the Safety Circuit). The other encoders, the limit-switches and FB1 & FB2 (the threading sensors) are connected to J1.

The pin-out for J1 is (a pin-out for a 25-pin D connector connected to the J1 ribbon cable is also given) ...

Pin	DB25 pin	Function
1	1	+5V
2	14	X encoder channel A
3	2	X encoder channel B
4	15	0V/GND
5	3	X limit +
6	16	X limit -
7	4	FB1 - single slot encoder for threading
8	17	U encoder channel A
9	5	U encoder channel B
10	18	+5V
11	6	Y encoder channel A
12	19	Y encoder channel B
13	7	0V/GND
14	20	Y limit +
15	8	Y limit -
16	21	FB2 - multi-slot encoder for threading

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17	9	V encoder channel A
18	22	V encoder channel B
19	10	+5V
20	23	Z encoder channel A
21	11	Z encoder channel B
22	24	0V/GND
23	12	Z limit +
24	25	Z limit -
25	13	+12V
26	NC	0V/GND

The X641BB break-out board can be used to easily separate and connect the signals.

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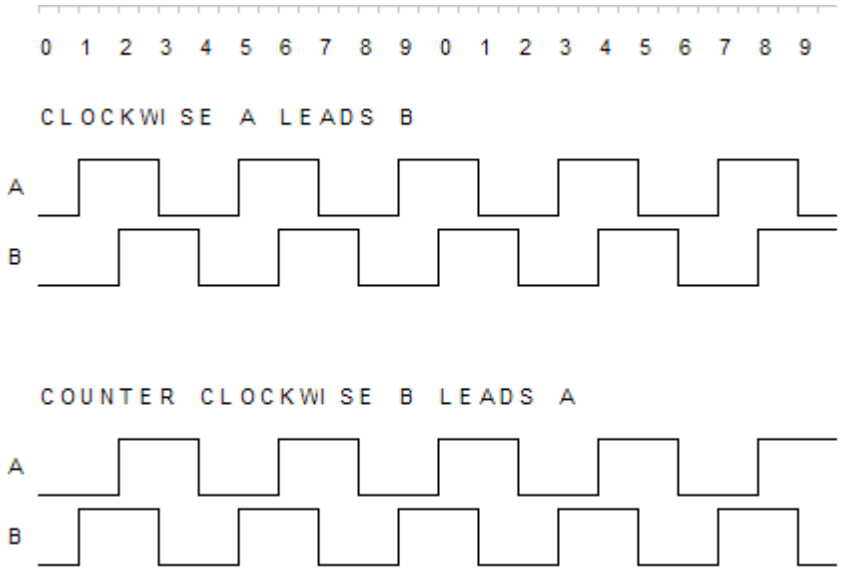
2.11.1 Quadrature-encoders

Quadrature-encoders output 2 pulse trains, A and B, which are out of phase. The 'quadrature' in the name is derived from the fact that there are 4 states for the 2 signals to be in... A-off-with-B off, A-on-with-B-off, A-on-with-B-on and A-off-with-B-on. The sequence of these states determines the direction of rotation of the encoder...



For feedback from the motors optical encoders are usually used...

...because they place no load on the drive system and can cope with the high speeds that motors

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and shafts may turn at. The encoder pictured is a rotary encoder with a slotted disk... the disk determines the resolution of the encoder... in this case 400 counts/rev. Optical encoders also come in strip or linear forms and there are other types of non-contact encoders that can be used (such as capacitance strips or magnetic proximity switches).

For the hand wheel a mechanical (cheaper!) encoder/switch can be used...

...these operate using a wafer switch but provide the same quadrature outputs as an optical encoder... they are just not suitable for high-speed or long-life applications. Another advantage of these mechanical encoders is that they often have detents (a cogging feel as they are rotated). The encoder shown is a Bourne ECW1J-B24-AC0024 it provides 96 counts per revolution and is the encoder we use for the hand wheel on the CNC1, CNC2 and CNC3 boxed controllers.

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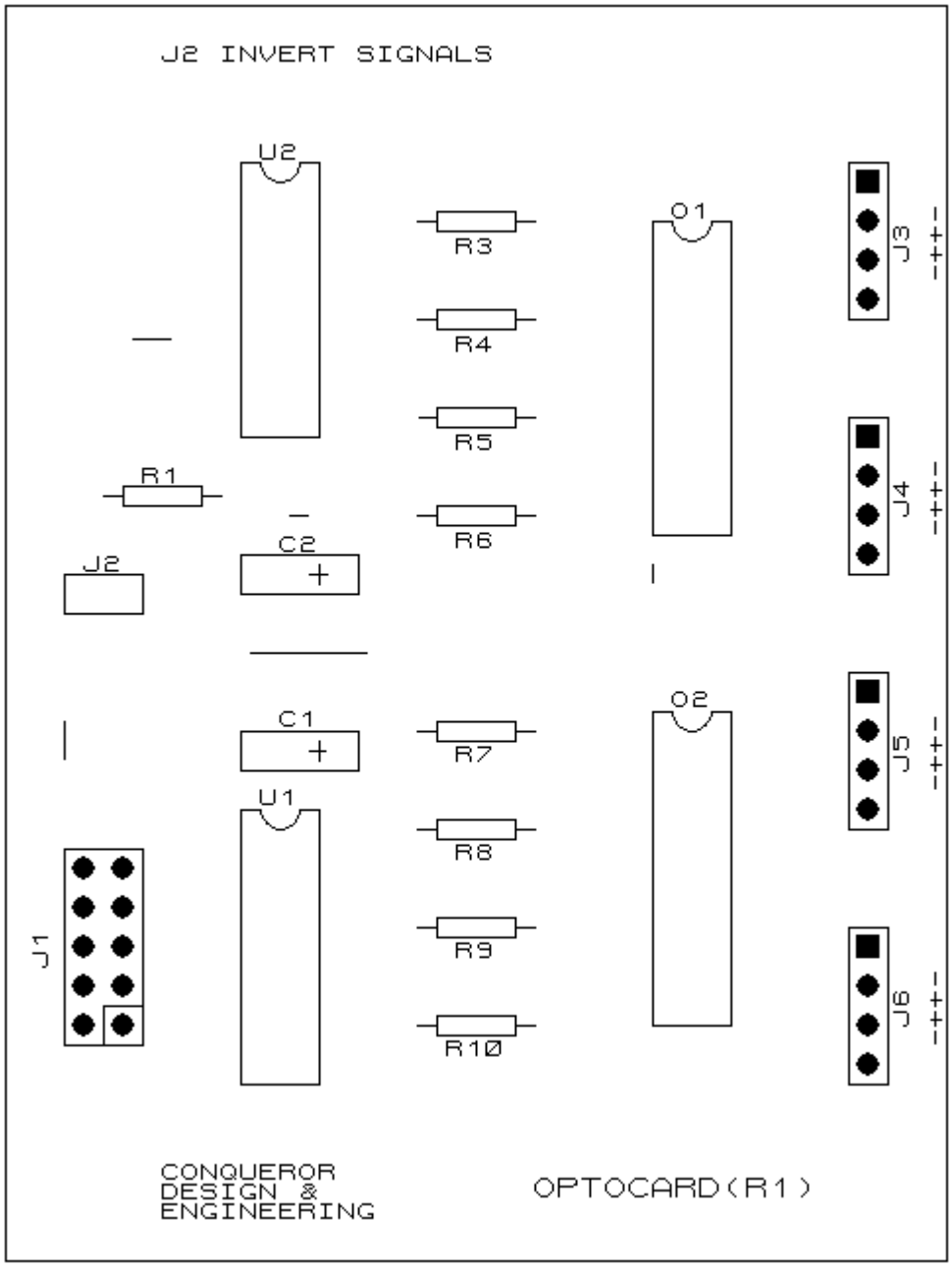
3 Optional accessories

3.1 Opto-isolator card, OPTOCARD



The opto-isolator card, **OPTOCARD(R1)**, allows the external stepper drive card signals to be connected to drive cards which do not operate at 5-volt TTL signal levels. The card also splits the direction signal into 4 separate outputs to make it easier to connect drive cards which need individual directions signals. The card is suitable for interfacing to logic levels of 5-50 volts.

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The J1 connector pin out is as follows...

Pin	Function
1	VCC (+5-volts).
2	Ground (0-volts).
3	STPX. Clock/Step-pulse for X motor.
4	STPY. Clock/Step-pulse for Y motor.
5	STPZ. Clock/Step-pulse for Z motor.
6	STPE. Clock/Step-pulse for E/U motor.
7	DIR. Motor step direction. Shared by all drives.
8	No connection.
9	No connection.
10	No connection.

The J2 connector can be used to invert the signals going to the external cards. The standard signals are active-low. Connecting a shorting link across J2 will make the signals active-high. The board is supplied with a shorting link on connector J2.

The J3, J4, J5 and J6 connectors are for connecting the external drive cards for the X, Y, Z and E/U motors respectively. The pin out of the connectors is (pin 1 is indicated by the square pad)...

Pin	Function
1	Step clock -
2	Step clock +
3	Direction +
4	Direction -

...each opto-isolator can shunt 25 mA. The opto-isolated outputs are only suitable for driving logic inputs. To connect to a standard logic interface the - (negative) terminal of the isolator will be connected to the ground (0v) rail of the logic system and the + (positive) terminal of the isolator will be connected to the logic signal. When the isolator is active current will flow from the + (positive) terminal to the - (negative) terminal.

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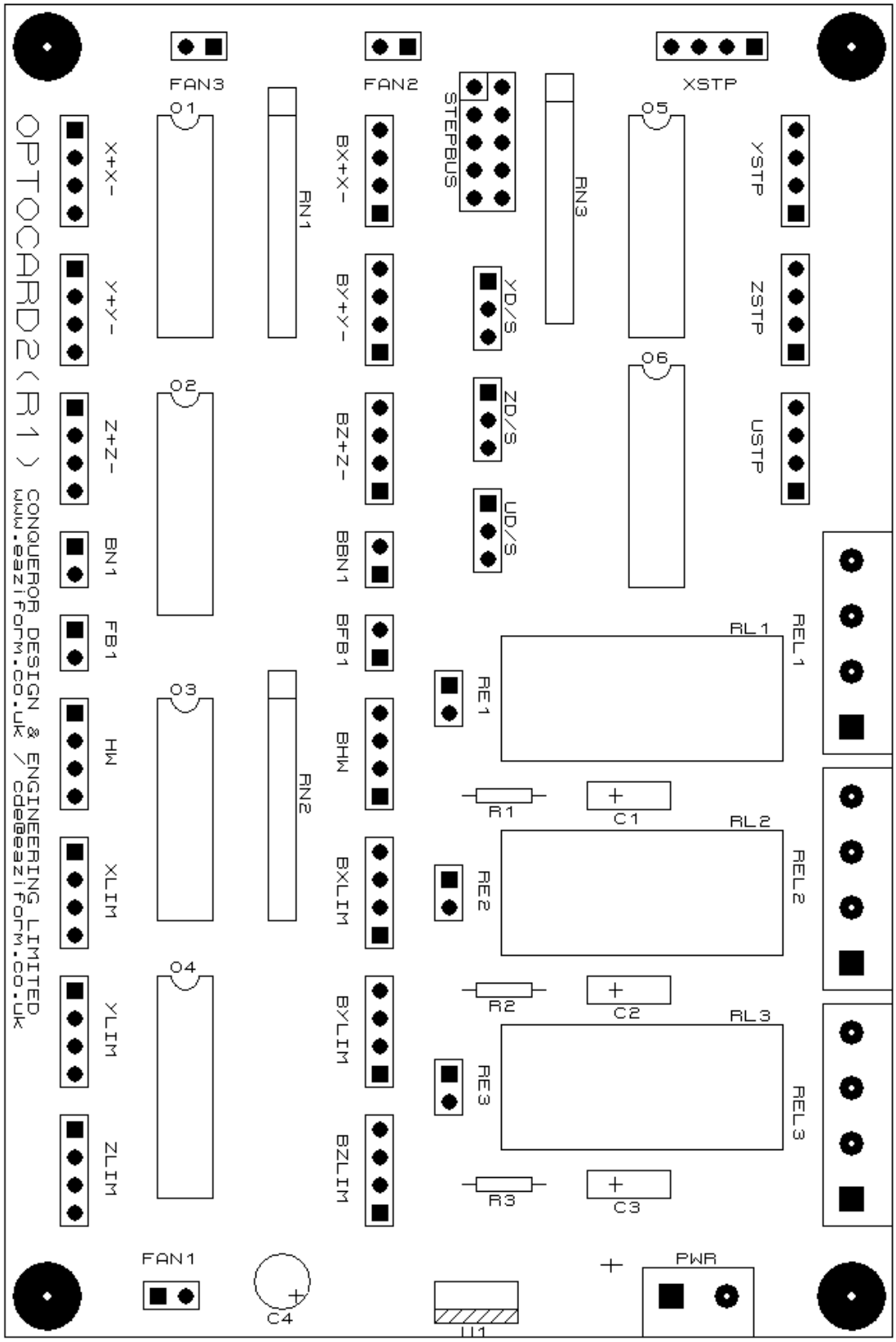
3.2 Opto-isolator/relay card, OPTOCARD2



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The opto-isolator card, **OPTOCARD2**, allows the external stepper drive card signals to be connected to drive cards which do not operate at 5-volt TTL signal levels. The card also splits the direction signal into 4 separate outputs to make it easier to connect drive cards which need individual directions signals. The card is suitable for interfacing to logic levels of 5-50 volts.

The OPTOCARD2 also includes power-relays for interfacing high-current loads to the X-card and optically-isolated jog-panel and limit-switch connectors which can operate at 12-volts.

The STEPBUS connector pin out is as follows...

Pin	Function
1	VCC (+5-volts).
2	Ground (0-volts).
3	STPX. Clock/Step-pulse for X motor.
4	STPY. Clock/Step-pulse for Y motor.
5	STPZ. Clock/Step-pulse for Z motor.
6	STPE. Clock/Step-pulse for E/U motor.
7	DIR. Motor step direction. Shared by all drives.
8	No connection.
9	No connection.
10	No connection.

The XSTP, YSTP, ZSTP and USTP connectors are for connecting the external drive cards for the X, Y, Z and E/U motors respectively. The pin out of the connectors is (pin 1 is indicated by the square pad)...

Pin	Function
1	Step clock -
2	Step clock +
3	Direction +
4	Direction -

...each opto-isolator can shunt 25 mA. The opto-isolated outputs are only suitable for driving logic inputs or other opto-isolators. To connect to a standard logic interface the - (negative) terminal of the isolator will be connected to the ground (0v) rail of the logic system and the + (positive) terminal of the isolator will be connected to the logic signal. When the isolator is active current will flow from the + (positive) terminal to the - (negative) terminal. The XD/S, YD/S, ZD/S and UD/S jumpers select whether the direction outputs for each connector are from the shared direction signal or separate direction signals.

The X+X-, Y+Y-, Z+Z-, etc. connect to the input plugs on the X641 card. The BX+X-, BY+Y-, etc. are the 12-volt buffered connections for the buttons and switches on the machine.

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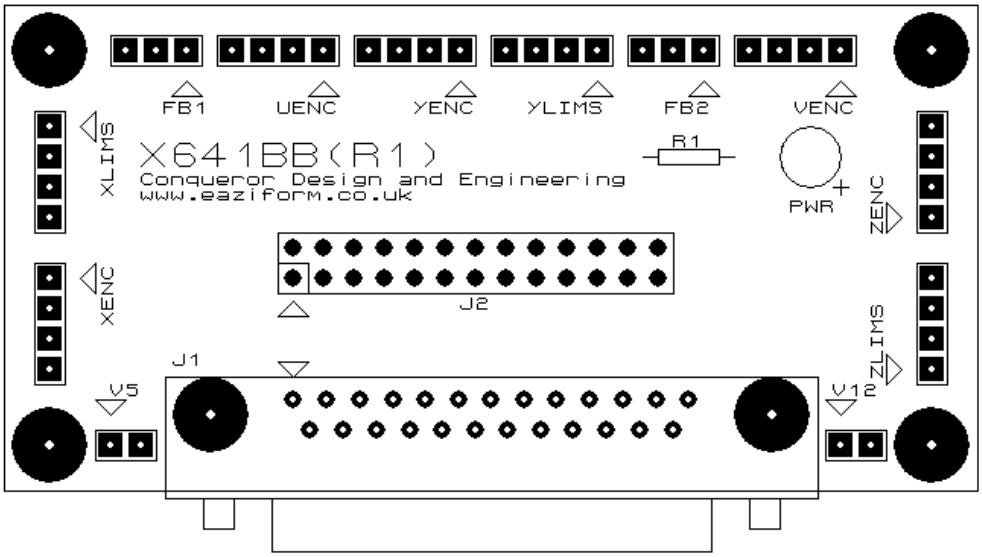
3.3 X641BB break-out board



There is an optional X641BB break-out board.

The break-out board can be used with the X641 card using a 26-pin ribbon cable or with CNC control boxes using a 25-pin extension cable.

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X641BB connector pin-outs

In all cases the marked pin is pin #1.

XENC, YENC, ZENC and UENC connector

Pin	Signal
1	+5 volts
2	A signal
3	B signal
4	GND

XLIMS, YLIMS and ZLIMS connector

Pin	Signal
1	+ Limit switch
2	GND
3	- Limit switch
4	GND

(To connect a limit switch connect it across 1 & 2 or 3 & 4)

FB1 and FB2 connector

Pin	Signal
1	+5 volts
2	Encoder signal
3	GND

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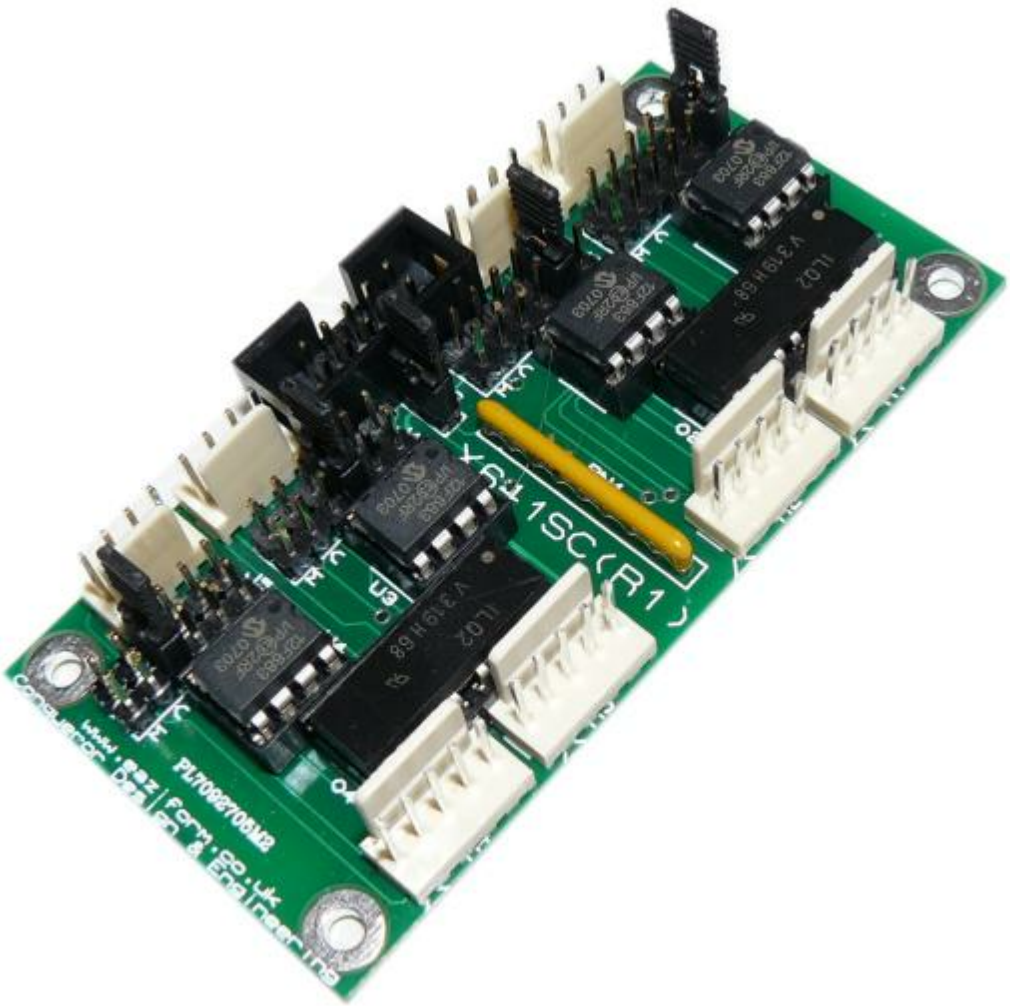
3.4 X641SC stepper-motor card interface board

The X641SC card is useful for interfacing to 3rd-party stepper motor drive cards.

The X641SC separates the drive signals to discrete connectors instead of the ribbon cable bus used by our stepper motor drive cards. Each output pin can drive a 25ma load and there are also opto-isolated outputs for converting the signals for non-logic voltage levels or across power busses.

Each X641SC card can address 4 stepper motor drive cards and each card address can be set as X, Y, Z, U, V or W. The direction signal is also buffered for each motor output for use with 3rd-party cards that may not support the shared direction signal that our cards use.

Multiple X641SC cards can be connected and a system mixing our stepper motor drive cards and 3rd-party drive cards is possible.



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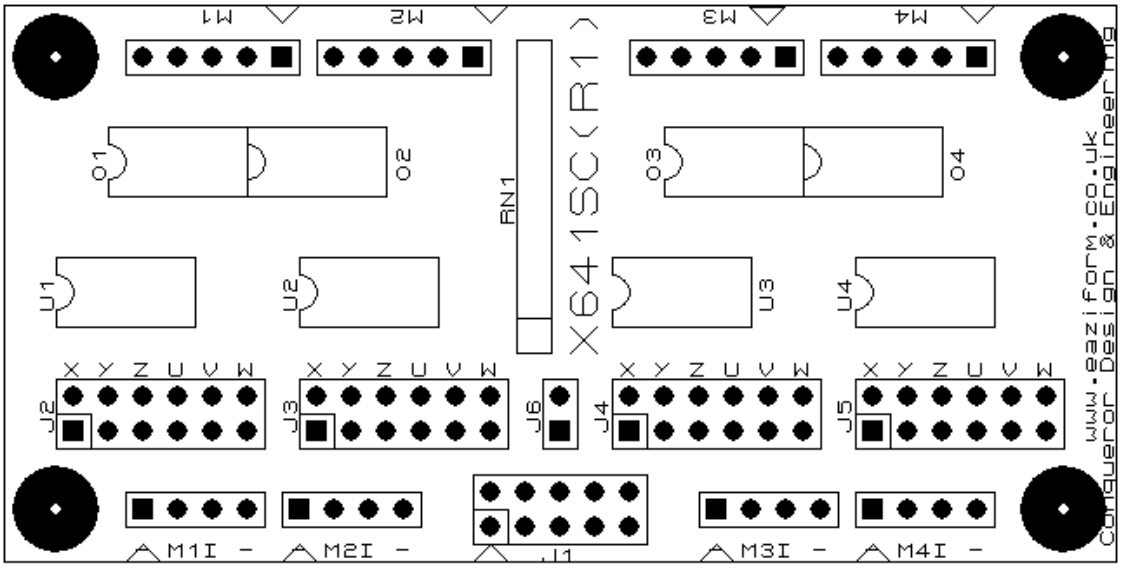

For easy reference the logic output connector and the opto-isolated connector are in-line with the jumper block which selects the axes. The logic connectors are 5-pins while the opto-isolated connectors are 4-pins. The enable signal is not present on the opto-isolated output.

The J1 pin-out is as follows... (this is compatible with M64x and X641 cards)

Pin	Function
1	VCC (+5-volts).
2	Ground (0-volts).
3	STPX. Clock/Step-pulse for X motor.
4	STPY. Clock/Step-pulse for Y motor.
5	STPZ. Clock/Step-pulse for Z motor.
6	STPU. Clock/Step-pulse for E/U motor.
7	DIR. Motor step direction. Shared by all drives.
8	Enable - shared by all drives
9	STPV. Clock/Step-pulse for V motor.
10	STPW. Clock/Step-pulse for W motor.

The M1, M2, M3 and M4 connector pin-outs are...

Pin	Function
1	VCC (+5-volts).
2	Clock/Step-pulse

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3	DIR - direction signal (buffered)
4	Enable (buffered)
5	Ground (0-volts).

Each logic level output on the M1, M2, M3 and M4 connectors can sink or source 25 mA.

The M1I, M2I, M3I and M4I connector pin-outs are...

Pin	Function
1	Clock/Step-pulse -ve (emitter)
2	Clock/Step-pulse +ve (collector)
3	Direction signal +ve (collector)
4	Direction signal -ve (emitter)

Each opto-isolator can sink 50 mA at up to 50 volts. Total power for each opto-isolator should not exceed 200 mW.

The jumper blocks J2, J3, J4 and J5 are used to select which clock/step-signal is used for each of the motor outputs M1, M2, M3 and M4 (also the opto-coupled M1I, M2I, M3I and M4I). Only one jumper should be placed on each block - the X, Y, Z, U, V and W markers on the board indicate the positions for the 1st, 2nd, 3rd, 4th, 5th and 6th axes.

The jumper J6 should only be fitted if the opto-isolated connections are going to be used - power dissipation can be reduced if the opto-isolators are not required. Generally if a motor drive card has logic level (5-volt) inputs then the opto-isolators do not need to be used - they only need to be used if the motor drive card requires higher-voltage or is connected to a power rail that does not share a common ground with the control card.

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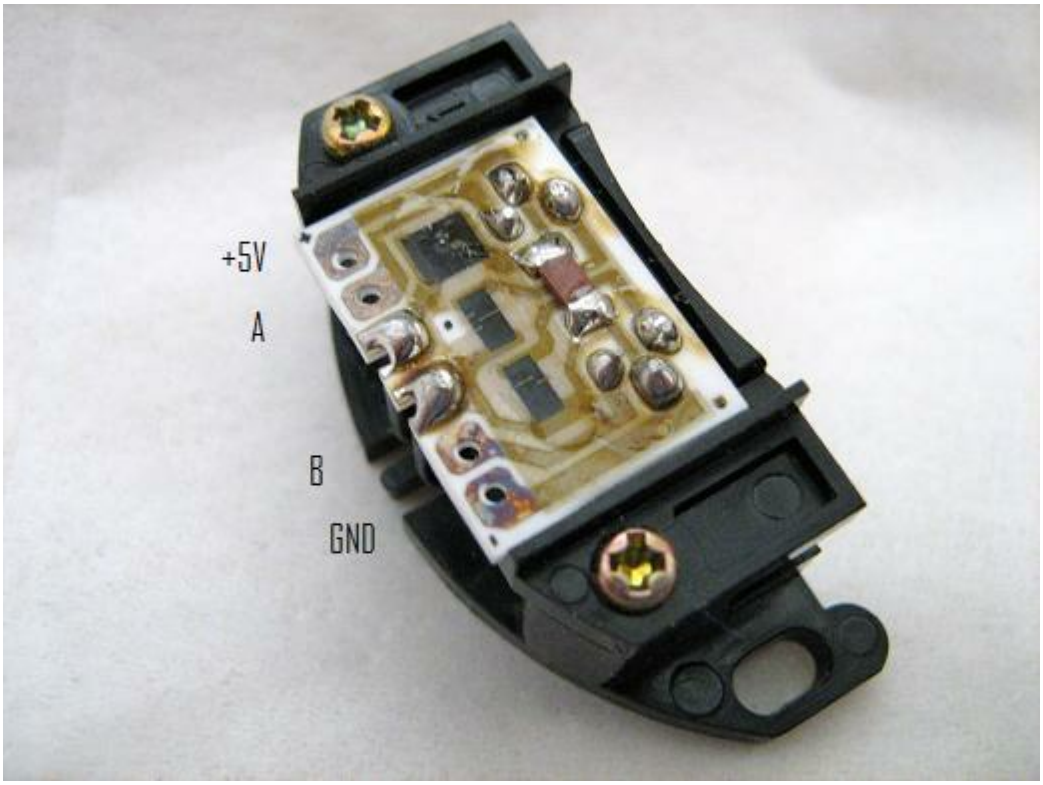
3.5 Encoder & photo-interrupter connections

3.5.1 GP1R11 quadrature-encoder



Sharp GP1R11 Quadrature-encoder and connections

The Sharp GP1R11 quadrature-encoder connections are shown above. There is a small plus mark next to the +5V connection and a small negative next to the GND connection.

Pin	Function
1	+5V
2	A channel of encoder
3	B channel of encoder
4	GND

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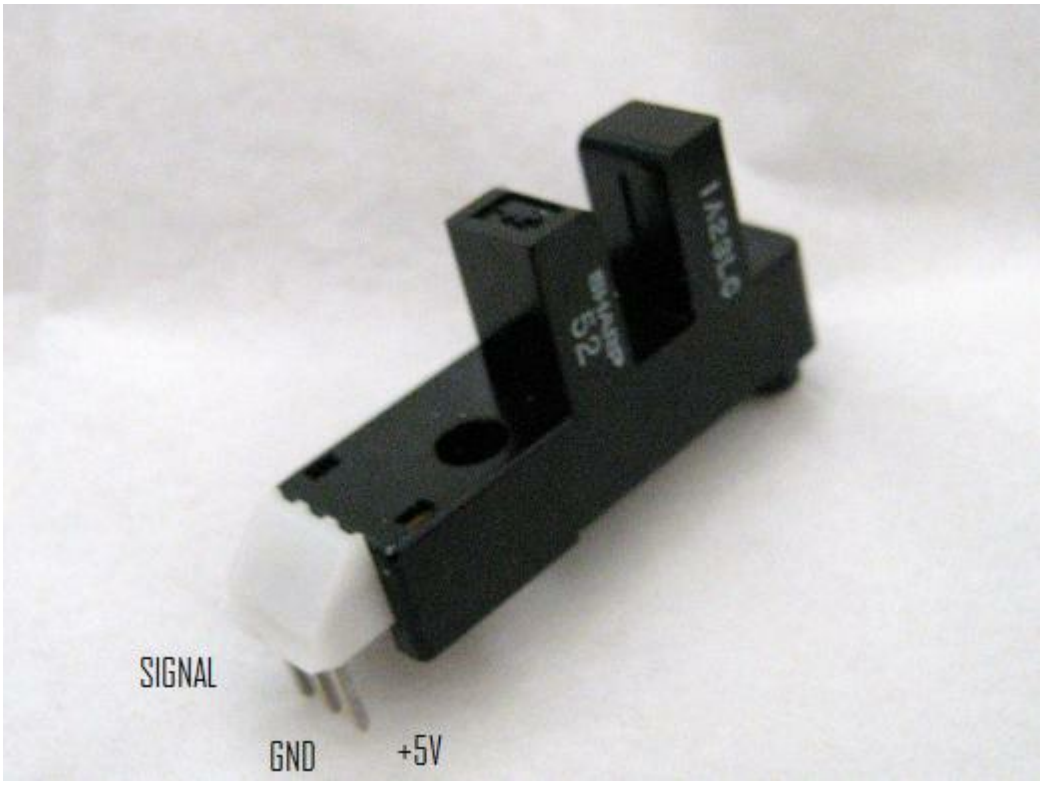
3.5.2 GP1A23 photo-interrupter



Sharp GP1A23 photo-interrupter

The Sharp GP1A23LC photo-interrupter connections are shown above. Pin 1 is closest to the lettering/marking on the part.

Pin	Function
1	+5V
2	GND
3	SIGNAL - photo-interrupter output

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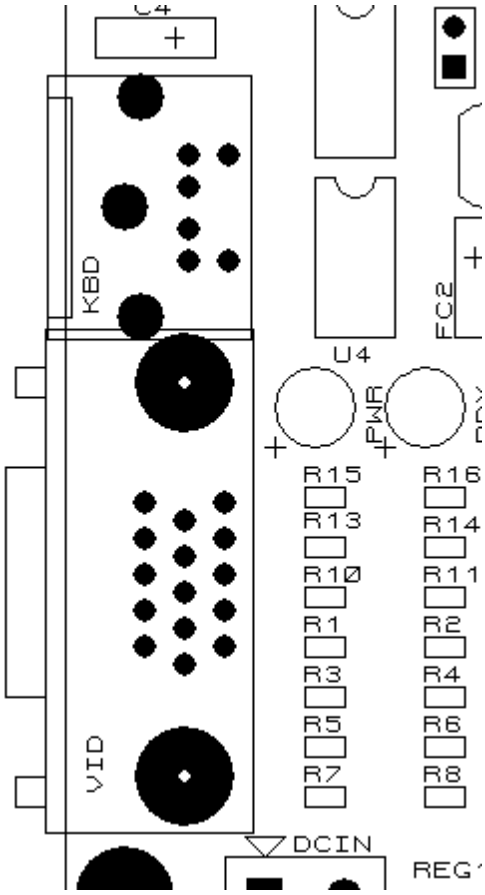
4 Operation without a computer



The X-card can operate without a computer.

A VGA monitor, either conventional or flat-panel TFT, can be plugged into the VID connector and a PS2 PC keyboard can be plugged into the KBD connector.

In stand-alone mode you can...
1. Operate the machine using the jog-buttons and hand-wheel
2. Operate the machine in MDI mode
3. Run programmes stored in the card RAM
4. Run programmes from a remote machine (DNC)
5. Edit tool offsets
6. Change parameters and settings

If a PC keyboard is attached the <Page-Up> and <Page-Down> keys can be used to switch modes also the <F1> key will select MDI mode, the <F2> key will select Run mode and the <F3> key will select the Edit mode. Other function keys are used by the various modes... these will be listed along the bottom of the display.

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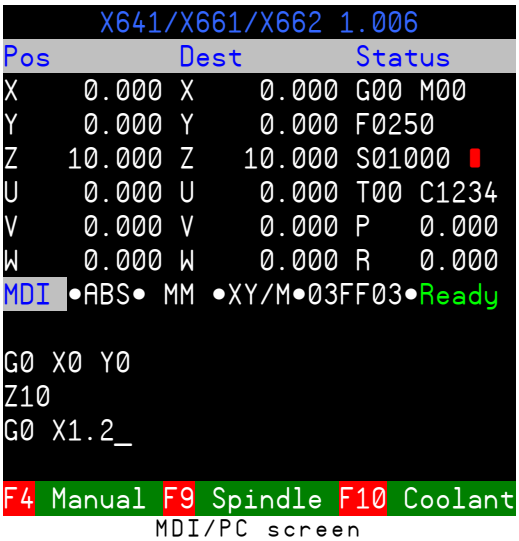
4.1 MDI/PC mode



MDI/PC screen

In MDI mode commands can be typed in and executed. You can also select manual mode for moving the machine using the jog-buttons and the hand-wheel.

After power-on and before any movement commands can be executed the power-on error (#3) needs to be cleared using the 'EC' command.

<F4> selects manual mode - the machine can be moved using the jog-button and the hand-wheel. The axis being controlled by the hand-wheel can be selected by pressing the <X>, <Y>, <Z>, <U>, <V> or <W> key in manual mode.

<F9> Turns the spindle on or off. The same can be done using the 'M3' and 'M5' commands.

<F10> Turns the coolant on or off. The same can be done using the 'M8' or 'M9' commands.

Datum can be set using the 'G92' command. For instance to set the X datum to 10 enter the command 'G92 X10'. Several datum can be set using one 'G92' command.

MDI commands are limited to 62 characters.

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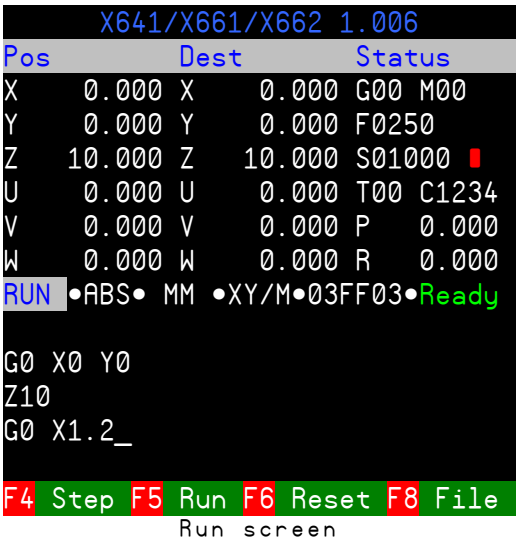
4.2 Run mode



Run screen

Run mode allows programmes from the memory to be executed.

<F4> will execute the current line

<F5> will execute the entire programme

<F6> resets the programme to the start

If you want to run part of a programme you can scroll to the starting point in the editor and then switch to the Run mode.

Pressing <Esc> will stop the programme execution.

NB. If a programme is stored with the name '9999' it will be loaded and automatically executed at startup. On startup the RDY LED will flash 5 times in 5 seconds to indicate that a programme is being auto-started and then the programme will run. The programme can be stopped by operating the safety before the power is turned on or by pressing the <Esc> key.

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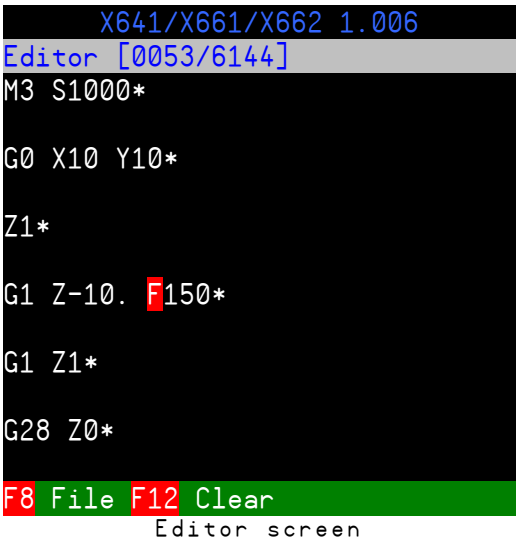
4.3 Editor mode



Editor screen

It is not possible to use the built-in editor without a PC keyboard plugged in.

The title bar shows the number of characters in the current programme and the maximum characters allowed.

<F8> will access the file menu for loading and saving programmes

<F12> will clear the programme memory

NB. Only files which have been saved will be kept after a power-off. The programme memory is always empty on power on unless the 'auto run' feature is being used.

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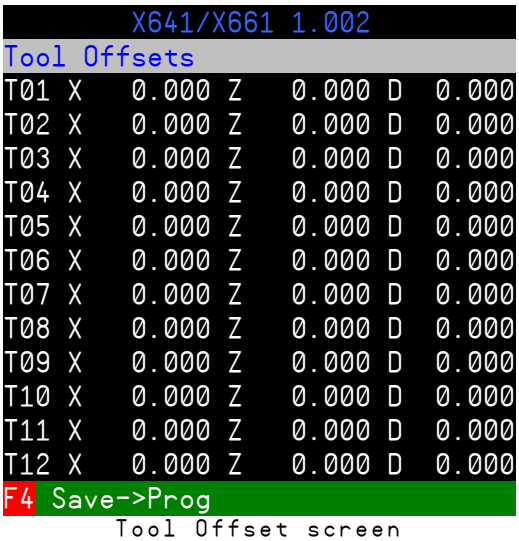
4.4 Tool Offsets



Tool Offset screen

The tool offsets are used when the tool-change code M6 is used.

The values are altered from the MDI screen.

<F4> will fill the programme memory with the tool table. This programme can be saved and the tool offsets reset later by running it.

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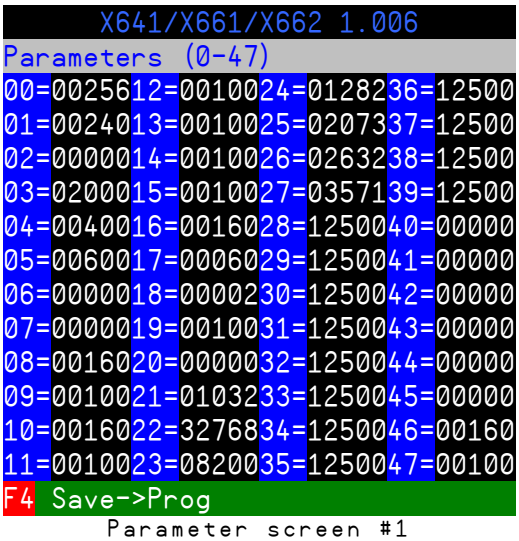
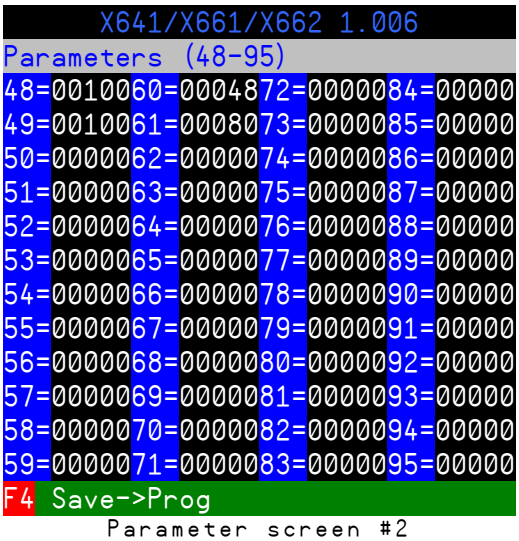
4.5 Parameter mode



Parameter screen #1



Parameter screen #2

For a list of the parameters see the appendices.

We recommend using EaziCNC 2 to set or change the parameters.

<F4> will fill the programme memory with the parameters. This programme can be saved and the parameters restored later by running it.

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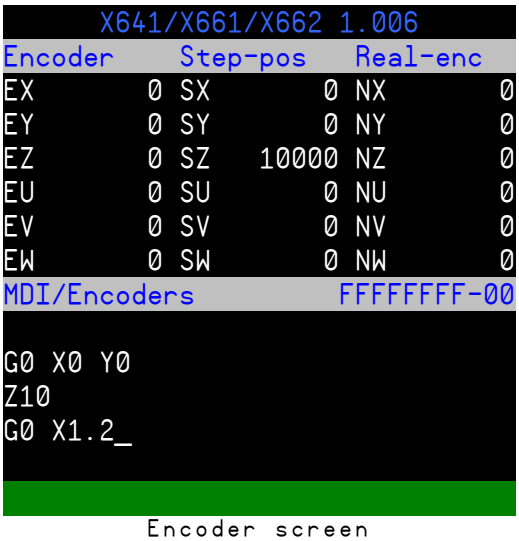
4.6 Encoder mode


X641/X661/X662 1.006
Encoder Step-pos Real-enc
EX 0 SX 0 NX 0
EY 0 SY 0 NY 0
EZ 0 SZ 10000 NZ 0
EU 0 SU 0 NU 0
EV 0 SV 0 NV 0
EW 0 SW 0 NW 0
MDI/Encoders FFFFFFFF-00
G0 X0 Y0
Z10
G0 X1.2_

Encoder screen

The encoder mode allows MDI commands to be executed while displaying the encoder counts and inputs.

The left column ('Encoder') shows the scales encoder values - these are the values after any scaling and are compared to the step-position to determine if any correction is needed when the axis is operating in closed-loop.

The middle column ('Step-pos') shows the current step-count for each axis.

The right-hand column shows the real-encoder count - this is the count of the encoder pulses before any scaling is applied.

In the middle on the right is shown the current input status - there are 32-inputs (see the table below) and the 8 hex digits show the state of all the inputs. The current status-code is shown after the inputs.

Input bit #	Input Name	P parameter for testing with M92 or M93
0	X+ jog button	0 (tests for any button active)
1	X- jog button	0 (tests for any button active)
2	Y+ jog button	0 (tests for any button active)
3	Y- jog button	0 (tests for any button active)
4	Z+ jog button	0 (tests for any button active)
5	Z- jog button	0 (tests for any button active)
6	BTN1	n/a
7	Safety circuit	n/a
8	FB1 (spindle encoder)	1
9	FB2 (spindle encoder)	2
10	X+ limit	3
11	X- limit	4

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Input bit #	Input Name	P parameter for testing with M92 or M93
12	Y+ limit	5
13	Y- limit	6
14	Z+ limit	7
15	Z- limit	8
16	X encoder A channel (F1)	9
17	X encoder B channel (F2)	10
18	Y encoder A channel (F3)	11
19	Y encoder B channel (F4)	12
20	Z encoder A channel (F5)	13
21	Z encoder B channel (F6)	14
22	U encoder A channel (F7)	15
23	U encoder B channel (F8)	16
24	V encoder A channel (F9)	17
25	V encoder B channel (F10)	18
26	W encoder A channel (F11)	19
27	W encoder B channel (F12)	20
28	Hand-wheel A channel (F13)	21
29	Hand-wheel B channel (F14)	22
30	F15 (on AUX connector)	23
31	F16 (on AUX connector)	24

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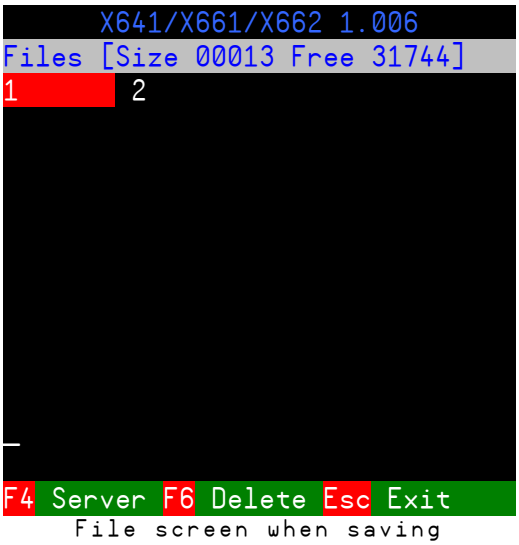
4.7 File Menu

File screen when loading



File screen when saving

The file menu displays the files in local memory. The files are sorted into numerical order. File names can range from 0-9999999. Names can be zero-padded.

The standard X-card has 32,256 bytes of storage available and space for 32 files.

You can use the left and right cursor keys to move between the files. The size of the current file will be shown in the header. The amount of free storage is also shown.

The file manager shows slightly different options when loading or saving. When saving the option to delete a file is shown.

Loading
To load a file move the selector to the correct file and then press <Enter>.

Saving
To save to a file type in the number to save under or scroll to the file to be overwritten. If

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number is typed and a file with the same number already exists it will be replaced.

<F4> Connects to a PC server

<F6> Deletes the selected file

<Esc> Exits the file menu without loading or saving a file

NB. If for any reason the file storage becomes corrupted it can be cleared and reformatted using the MDI command 'P9999 R9999'.

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4.8 Monitor sync control

The sync signal can be controlled to allow use with a variety of monitors.

The standard sync timing (100) should be suitable for most monitors.

In the MDI mode...

<Alt-F10> will set the sync timing to 75

<Alt-F11> will set the timing to 100

<Alt-F12> will increase the timing by 5 units across a range from 75-125

Other values can be programmed using 'P59 Rxx'.

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5 Direct control via the RS232

It is possible to control the X-card directly from the serial port without using the EaziCNC or EaziCNCLite programmes.

The X-card accepts a subset of the full set of G & M codes (for instance no canned cycles) that EaziCNC supports, coordinates need to be in millimetres and only absolute positioning is supported. Also you need to deal with the handshaking from the machine to make sure that commands do not get overwritten before they can be executed.

To test this from, for instance, HyperTerminal...

1. Open a connection to the X-card at 115200 baud, 8 data bits, no-parity and 1 stop bit with Xon/Xoff handshaking.
2. Type <CTRL+E>... this will turn on the echo so that you can see the keys typed and the responses from the X-card. You should also turn on the option to add line-feeds to carriage returns (*N.B. <CTRL+N> turns the echo off... the controller will not send anything back via the RS232 that is not requested... this keeps the interface 'clean' for very rapid communication from a programme like EaziCNC*).
3. If you hit <Enter> you should see the '>' prompt.
4. You can now enter commands such as 'ST' to show the status, 'M3' to turn on the spindle and 'G0 X10' to move (before you do any moves you may need to send an 'EC' to clear the error-state... by default the controller will power-up with error #3 - power-on).
5. To see a rolling display of the coordinate changes as a movement command is executed you need to attach a VGA monitor.
6. The controller will send status information back to a control programme if certain characters are sent... for instance sending a '@' will return X, Y, Z and E positions, the key panel code and a status byte as a packed hexadecimal string. There are other codes which will return information from the box either as text, packed hexadecimal or binary-blobs.

In the raw 'terminal' mode any axis commands (such as 'X10' or 'Y1.26') will be interpreted as millimetres using the parameters to convert them into an accurate number of steps... the coordinates shown by the status commands are also shown in millimetres. Any of the commands that return data in a packed format return the raw step values.

There are a couple of ways to go depending on how sophisticated your control of the machine needs to be... you can either write your own interface to the controller which sends commands out of the serial port direct *or* there is a DLL available which contains a 'virtual'-machine that supports all of the commands that EaziCNC does and that can be easily integrated into any programme. The DLL takes care of all the serial communication to the machine and exposes a command function and a query function to the calling programme.

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6 Customization

There are a number of ways to customize the operation of the X-series.

1. The parameters can be used to modify the operation
2. A programme can be stored in the internal memory to override the normal operation - at present this is supported for startup (9999) and for the M94 - index tool (9994)

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6.1 Control Option #1

Control option #1 can be enabled using bit 10 of parameter 0.

From firmware version 1.006 R000094 onwards this option allows the operation of the jog-buttons to be reassigned to select the axis which the jog-wheel is controlling... closing the X+ jog-buttons selects the X axis, the X- buttons the Y axis, the Y+ button the Z axis and so on. If more than one jog-button is activated the 1st corresponding axis in the order X, Y, Z, U, V, W will be selected.

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7 Appendices

7.1 G-Codes

G-Code	Parameters	Description
G00*	X, Y, Z, E	Rapid Move
G01*	X, Y, Z, E, F	Feed Move
G02*	X, Y, Z, E, I, J, K, F, R	Arc Clockwise Move
G03*	X, Y, Z, E, I, J, K, F, R	Arc Counter-Clockwise Move
G04	S	Dwell. S=Seconds to delay.
G06*	X, Y, Z, E, A, B, C, D, P	Spline functions (Cubic curve) (only available when running with the EaziCNC software)
G07*	X, Y, Z, E, A, B, C, D, I, J,K, L, P	Spline functions (Bezier curve) (only available when running with the EaziCNC software)
G17	-	Use XY plane for circular interpolation (Top)
G18	-	Use XZ plane for circular interpolation (Front)
G19	-	Use YZ plane for circular interpolation (Side)
G28	X, Y, Z, E	Home Axis
G40	-	Tool-nose compensation off (default mode)
G41	R	Tool-nose compensation Left-of-Line
G42	R	Tool-nose compensation Right-of-Line
G43	-	Tool-length compensation (positive)
G44	-	Tool-length compensation (negative - default mode)
G45	-	Cancel Tool-length compensation.
G54	X, Y, Z, E	Set home/reset position.
G70	-	Imperial coordinates (only available when running with the EaziCNC software)
G71	-	Metric coordinates (default mode)
G90	-	Absolute coordinates (default mode)
G91	-	Incremental coordinates (only available when running with the EaziCNC software)
G92	X, Y, Z, E	Set datum point.

N.B. The E axis can also be programmed as U.

*N.B. The codes marked with * are modal. Modal codes are active on any subsequent lines that do not have a code given.*

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7.1.1 Additional G-codes for lathe operations

G-Code	Parameters	Description
G33	X, Z, P, I	Threading(/synchronized) cut. P is pitch, I is end pull-out in X.
G80	-	Cancel Canned Cycle
G81*	X, Z, P	Turning cycle
G82*	X, Z, P	Taper cycle
G83*	X, Z, I, K, R, P	Arc Clockwise Cycle
G84*	X, Z, I, K, R, P	Arc Counter-Clockwise Cycle
G85*	X, Z, P	Facing Cycle
G86*	X, Z, P, I, K, R	Threading(/synchronized) cut cycle. X is pass offset (pass depth). P is pitch, I is end pull-out, K is pass offset in Z and R is number of passes.
G94	-	Feed rates in mm./in. per minute
G95	-	Feed rates in mm./in. per spindle revolution
G96	-	Constant surface speed. Feed rate specified in mm. at 20.0 mm. diameter. Feed rate specified in inches at 1.0 inch diameter.

N.B. The E axis can also be programmed as U.
*N.B. The codes marked with * are modal. Modal codes are active on any subsequent lines that do not have a code given.*

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7.1.2 Additional G-codes for milling operations

G-Code	Parameters	Description
G50	-	Mirror Off. Cancel any mirrored axis.
G51	X, Y, Z, E	Mirror. Mirror selected axis (around coordinate given).
G55	-	Offset Off. Cancel/Clear temporary origin
G56	X, Y, Z, E	Offset. Set temporary origin.
G80	-	Cancel/Complete Canned Cycle.
G81*	Z	Drill, Spot-Drill
G82*	Z, K	Peck Drill
G83*	Z, P	Tapping
G84*	Z	Bore
G85*	Z, P	Pocket cycle.

N.B. The E axis can also be programmed as U.
*N.B. The codes marked with * are modal. Modal codes are active on any subsequent lines that do not have a code given.*

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7.2 M-codes

M-Code	Parameters	Description
M00	-	Programme Stop
M01	-	Optional Stop
M02	-	Programme End (same as M30)
M03	S	Spindle Start Clockwise
M04	S	Spindle Start Counter-clockwise
M05	-	Spindle Stop
M06	R, T, X, Y, Z	Tool Change
M08	-	Coolant On
M09	-	Coolant Off
M13	S	Spindle Start Clockwise + Coolant On
M14	S	Spindle Start Counter-clockwise + Coolant On
M15	-	Spindle Stop + Coolant Off
M30	-	Programme End (same as M02)
M47	R	Return to Programme Start. R is the repeat count (if given) and P is the label (N) to repeat from.
M90	P	Relay P On
M91	P	Relay P Off. A P99 will turn all outputs off.
M92	P	Wait for input P to be Low
M93	P	Wait for input P to be High
M94	-	Index tool-post. Indexes the tool-post (if fitted) forward.
M98	-	Motor Drives On
M99	-	Motor Drives Off

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7.3 Command set

Command	Parameters	Description
Ctrl-B (#2)	-	Query. Used by the EaziCNC software.
Ctrl-E (#5)	-	Echo On. Echoes characters back to the terminal and enables user friendly responses (data sent to the terminal will have a tag, i.e, "P0:0" instead of just "0").
Ctrl-N (#14)	-	Echo Off. Stops characters from being echoed back to the terminal and disables user friendly responses.
<ESC>	-	Escape. Stops any current moves or commands. Clears the command buffers. This command does not need to be completed with a carriage return (CR).
@	-	At. Returns the current position and status data in compressed hex format. This command does not need to be completed with a carriage return (CR).
EC	-	Error Clear. Clears any error state on the machine. *N.B. this clears user-stops, power-up errors, etc. it will not and cannot clear errors such as 'safety activated'.*
ES	-	Error Status. Displays the error code of the machine. Error codes... 0 - No error 1 - Stopped by user 2 - Stopped - safety activated 3 - Power interrupted 4 - X-limit triggered 5 - Y-limit triggered 6 - Z-limit triggered 7 - E-limit triggered
I	n<CR>	Info. <n> is the item of information 0 - board ID 1 - firmware version 2 - firmware date 3 - processor type <blank> - firmware banner
MA	<CR>	Manual Mode. To exit manual mode the <ESC> command must be sent.
P	n[Rv]<CR>	Parameter. Query (or set) a parameter. See control parameters for a description. P99 will display parameters 0 to 19, P199 will display parameters 20 to 39 and P299 will display parameters 40 to 59.
SX	f<CR>	Set X coordinate to <f>

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SY	f<CR>	Set Y coordinate to <f>
SZ	f<CR>	Set Z coordinate to <f>
SE	f<CR>	Set E coordinate to <f>
SH	<CR>	Show Home. Displays the currently set home/ starting position (set by a G54 command).
ST	<CR>	Status. Show current status.
T	X, Y, Z	Set/display tool offset. If no X, Y or Z is given then the existing offset will be displayed. T99 will list all tool offsets.

Any valid ISO line will also be interpreted and executed on the machine tool. For a list of valid ISO (G&M-codes) see G-Codes and M-Codes.

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7.4 Control parameters

Parameter	Type	Description
0	Binary	Configuration 1 - bit 0 - X axis direction bit 1 - Y axis direction bit 2 - Z axis direction bit 3 - U axis direction bit 4 - X axis home direction bit 5 - Y axis home direction bit 6 - Z axis home direction bit 7 - U axis home direction bit 9 - turn off motors when idle bit 10 - reserved bit 11 - reserved bit 12 - reserved bit 13 - Relay 4 is reserved for motor reverse bit 14 - tool carousel on motor U bit 15 - reserved bit 16 - Enable hand-wheel to be used for feed-rate override
1	Binary	Configuration 2 - bit 0 - reserved bit 1 - reserved bit 2 - reserved bit 3 - reserved bit 4 - X limits active bit 5 - Y limits active bit 6 - Z limits active bit 7 - U limits active bit 8 - X limit positive is NC (normally closed) bit 9 - X limit negative is NC (normally closed) bit 10 - Y limit positive is NC (normally closed) bit 11 - Y limit negative is NC (normally closed) bit 12 - Z limit positive is NC (normally closed) bit 13 - Z limit negative is NC (normally closed) bit 14 - U limit positive is NC (normally closed) bit 15 - U limit negative is NC (normally closed)

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2	Integer	Minimum Spindle Speed. Default=200 RPM
3	Integer	Maximum Spindle Speed. Default=2000 RPM
4	Integer	Maximum Cutting Feed Rate. Default=400 mm./min.
5	Integer	Rapid Feed Rate. Default=800 mm./min.
6	Integer	Pulses/Revolution on Threading/ Synchronizing Encoder. Default=360 [Setting this to 0 will cause the slots to be counted]
7	Integer	Default Circular Interpolation Mode. 0=XY, 1=XZ, 2=YZ.
8	Integer	X-scale (X-step size in millimetres = (P9/ P8)/P19)
9	Integer	X-divisor (X-step size in millimetres = (P9/ P8)/P19)
10	Integer	Y-scale (Y-step size in millimetres = (P11/ P10)/P19)
11	Integer	Y-divisor (Y-step size in millimetres = (P11/P10)/P19)
12	Integer	Z-scale (Z-step size in millimetres = (P13/ P12)/P19)
13	Integer	Z-divisor (Z-step size in millimetres = (P13/P12)/P19)
14	Integer	E/U-scale (E-step size in millimetres = (P15/P14)/P19)
15	Integer	E/U-divisor (E-step size in millimetres = (P15/P14)/P19)
16	Integer	Scalar for Feed rates. Steps/ sec=625,000*P17/(Feed*P16).
17	Integer	Divisor for Feed rates. Steps/ sec=625,000*P17/(Feed*P16).
18	Integer	Decimal digits in coordinates. Default=3 digits
19	Integer	Divisor for coordinates. Default=1000
20	Binary	Low byte - Control capabilities. Do not alter! High-byte - X, Y and Z axis mapping
21	Integer	Delays for carousel tool post. Forward delay = (low byte + 1)*0.25 secs Reverse delay = (high byte + 1)*0.25 secs [For stepper driven carousels 32768 (high bit) + steps/100. Reverse is half of

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		forward steps]
22	Integer	Time-out for manual mode and automatic motor turn-off. Default value is 2344 which gives a 5 minute delay. Delay in seconds = (P22 * 32) / pull-in-rate
23	Integer	Ramp stages (Maximum 16)
24	Integer	Ramp 0
25	Integer	Ramp 1
26	Integer	Ramp 2
27	Integer	Ramp 3
28	Integer	Ramp 4
29	Integer	Ramp 5
30	Integer	Ramp 6
31	Integer	Ramp 7
32	Integer	Ramp 8
33	Integer	Ramp 9
34	Integer	Ramp 10
35	Integer	Ramp 11
36	Integer	Ramp 12
37	Integer	Ramp 13
38	Integer	Ramp 14
39	Integer	Ramp 15
40	Integer	Back-lash compensation for X axis (steps)
41	Integer	Back-lash compensation for Y axis (steps)
42	Integer	Back-lash compensation for Z axis (steps)
43	Integer	Back-lash compensation for E/U axis (steps)
44	Integer	Back-lash compensation for V axis (steps)
45	Integer	Back-lash compensation for W axis (steps)
46	Integer	V-scale (V-step size in millimetres = (P47/P46)/P19)
47	Integer	V-divisor (V-step size in millimetres = (P47/P46)/P19)
48	Integer	W-scale (W-step size in millimetres = (P49/P48)/P19)
49	Integer	W-divisor (W-step size in millimetres = (P49/P48)/P19)
50	Integer	X-encoder scale (scale=low-byte, divisor=high-byte)
51	Integer	Y-encoder scale (scale=low-byte, divisor=high-byte)

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52	Integer	Z-encoder scale (scale=low-byte, divisor=high-byte)
53	Integer	U-encoder scale (scale=low-byte, divisor=high-byte)
54	Integer	V-encoder scale (scale=low-byte, divisor=high-byte)
55	Integer	W-encoder scale (scale=low-byte, divisor=high-byte)
56	Integer	Number of steps to retract from limit after a G29
57	Integer	Enable/disable feedback for axes. Bits... [15-6 reserved][5 - W][4 - V][3 - U][2 - Z][1 - Y][0 - X]
58	Integer	Low-byte - encoder gap (0..15) High-byte - encoder error limit (0=ignored/try-forever)
59	Integer	Sync signal control for VGA monitor (0 by default)
60	Binary	Control capabilities (read-only) bit 0 - uses raw-steps bits 1-3 - reserved bit 4 - supports U&V (6-axis) bit 5 - supports feedback (closed-loop) bits 6-15 - reserved
61	Integer	Processor clock speed in Mhz
62	Integer	XJOY register (nibbles) [U][Z][Y][X] If an encoder number is used then the axis will follow that encoder. This is different from feedback and is intended for use with the XJOY card
63	Integer	XJOY register (nibbles) [ ][ ][W][V]
64	Binary	Mask for which relays are turned off if the safety circuit is activated [004321CS] Normally although the spindle (S) and coolant (C) relays are turned off by the safety circuit they are not deactivated so when the safety is restored they will still be in the ON state. Settings bit in the mask turns the relay off when the safety is activated.

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7.5 Remote programme control/updating

There are a number of special parameters that can be used to control the programme store on the X-series cards remotely (the firmware must be 1.006 or later)...

Parameter	Type	Description
9990	Integer	Load programme - the programme number is given as the parameter value R.
9991	Integer	Save programme - the programme number is given as the parameter R.
9992	Integer	Clears the programme store - the parameter must be non-zero.
9993	Integer	Sets the programme pointer to the top of the programme - the parameter must be non-zero.
9994	Integer	Get a line of the programme - the parameter must be non-zero.
9995	Integer	Lists the whole programme to the serial port - parameter must be non-zero.
9996	Integer	Erases a programme from the programme store - the programme number is given as the parameter value R.
9998	Integer	Unlocks the programme store - parameter must be '1234'. The store will remain unlocked until the card is reset or another 'P9998' with an incorrect parameter value is received.
9999	Integer	Format/Erase programme store - the parameter R must be 9999 for the store to be cleared. Formatting the programme store is possible whether the store is unlocked or not.

A programme line can be preceded by a '%' to store the line into the programme memory instead of executing it.

If a programme is stored as 9999 then it will be loaded and run whenever the card is powered on.

If a programme is stored as 9994 then it will be loaded and run each time an M94 is executed. This allows the default tool-change behaviour to be re-programmed.

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